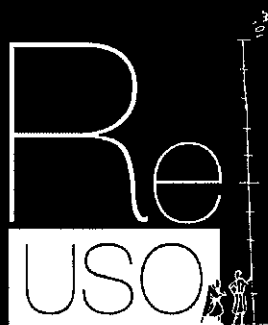


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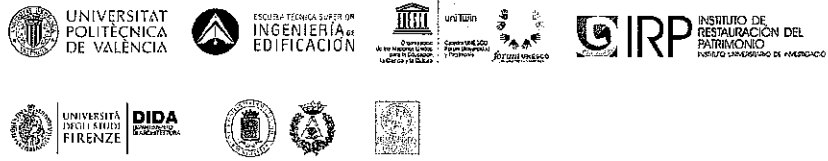
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Valencia, septiembre 2015

El Comité Organizador del III Congreso Internacional Documentación, Conservación y Reutilización del Patrimonio Arquitectónico y Paisajístico ReUSO
2015 Valencia

PRESENTACIÓN

En Junio del año 2013 se celebró en la Escuela Técnica Superior de Arquitectura de Madrid la primera edición del Congreso Internacional que ahora nos ocupa y que con el nombre de La experiencia del ReUSO trataba de intercambiar experiencias y criterios sobre nuevos usos en los espacios arquitectónicos. Esta iniciativa compartida con el DIDA, Dipartimento di Architettura de la Facultad de Florencia, pretendía la repetición del evento en la ciudad italiana tal y como sucedió en el mes de noviembre de 2014, donde además se incorporaban en el título de la convocatoria dos palabras, *conservazione e recupero*, que daban mayor amplitud a la convocatoria motivadas por la diversidad de propuestas presentadas y tratadas en Madrid. Florencia, como no podía ser menos, fue un éxito de participación y sirvió para comprobar de nuevo el interés de las secciones del Congreso, a nivel europeo y mundial, por lo tanto no podíamos (y aquí es en origen donde interviene Valencia), dejar cerrado un evento entre dos Universidades amigas con las cuales desde hace años venía colaborando personalmente... queríamos más. Se aceptó la propuesta de Valencia, Universitat Politècnica de València y en este caso, una escuela tecnológica como es la Escuela Técnica Superior de Ingeniería de Edificación, para organizar la III edición del Congreso, abriendo una nueva etapa de futuras sedes. Por ello con gran satisfacción puedo anunciar la continuidad del evento para el próximo 2016 en la ciudad italiana de Pavía, quedando a la espera nuestra querida ciudad de Granada para el 2017, a las cuales les deseamos éxitos futuros. El Programa como en las ediciones anteriores es variado en cuanto a temas y secciones, incorporando en Valencia como novedad la sección 6 relativa a la intervención sobre el patrimonio histórico y la experiencia educativa. Todas las escuelas arriba mencionadas, reflejan en sus programas docentes asignaturas sobre intervenciones en edificios históricos, por lo que pensamos que inculcar la pasión por los temas del Congreso ya desde las aulas, es algo que dará sus frutos tanto en la concienciación hacia la sensibilidad a la hora de actuar sobre estos edificios, como en la apertura de nuevos horizontes profesionales. Asimismo, también se incorpora la compatibilidad de la eficiencia energética, aspecto fundamental hoy en día para una rehabilitación eco-eficiente. Las demás secciones que componen la estructura del congreso abarcan prácticamente la totalidad de cuestiones en el campo de la conservación y recuperación y no solo en el campo edificatorio, es necesario

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considerar los aspectos urbanos, los paisajes, monumentos y entornos. Esta edición de las Actas en formato digital y que responde al gran número de contribuciones presentadas, (cerca de trescientas treinta), no hace más que corroborar la necesidad, ya citada, de continuar con futuras ediciones que dejen un camino trazado para los profesionales, expertos, investigadores, docentes, estudiantes e interesados en general, quienes a través de sus intervenciones pongan en valor el patrimonio existente, y ante el trabajo realizado nos haga pensar: valía la pena.

Valencia, septiembre 2015

Luis Palmero
Director

ÍNDICE

TEMA 1. CRITERIA AND METHODS OF INTERVENTION IN TIMES OF CRISIS

Adela Rueda Márquez de la Plata; Pablo Alejandro Cruz Franco	
The existing and widespread demand for a new architecture between 1842 and 1851. The beginning of the possibilities of reuse in architecture.....	32
Maria Bostenaru Dan	
Water as hazard and water as heritage in the first half of the 20th century.....	40
Anna Delera; Paolo Carli	
Participatory planning and densification: elements for the renovation of public neighborhood.....	48
Maria Cristina Forlani; Stefania De Gregorio	
Building reuse and urban revitalization.....	54
Andrea Arrighetti	
Constructive and seismic history of the Sant'Agata del Mugello parish church.....	64
Lorena Marina Sánchez; Laura Zulaica	
Indicators of patrimonial sustainability: The Challenge	71
María Argenti; Emilia Rosmini	
Architectural hybridization. The colonization as a new strategy to inhabit within the abandoned urban areas.....	79
Ana Teresa Cirigliano Villela; Regina Andrade Tirello	
Archaeology of architecture: the evaluation of the Harris Matrix to architectural stratifications.....	87
Marijn van de Weijer	
Heritage and regeneration – Moving from centre to periphery.....	95
Patricia Reus; Jaume Blancafort	
Get what you need managing what is available.....	103
Jaume Blancafort; Patricia Reus	
A strategy in the recycling of industrial ruins.....	110
Filomena De Robertis	
The characters of the mediterranean identity: José y Antoni Coderch de sentmenat and the building envelope.....	118
Annarita Teodosio	
Knowledge and conservation of industrial historic heritage. Recovery and enhancement of the workers villages in italy.....	126
José Gabriel Bernabé Collados; Félix Lasheras Merino	
Rationalist architecture, to preserve, to rehabilitate.....	134
Natália Miranda Vieira-de-Araújo	
Sectacularization of historic sites taken to an extreme degree: the unthinkable reconstruction proposal for Rome's coliseum.....	142
Maria Luisa Germanà	
The 'use' in the reliable interventions on the mediterranean architectural heritage.....	150

Angela Silvia Pavesi; Ilaria Oberti; Giordana Ferri; Roberta Condit	
Enhancement of building stocks through the social housing.....	158
Francesco Costanzo	
Designing for the “first life” of non-finite architectural heritage.....	166
Andrea Ordóñez León	
Evolve to stay. Contemporary forms of adaptation and transformation of residential urban fabrics in the historic city.....	174
Victor Pérez-Eguíluz; Alfonso Álvarez Mora; Juan Luis de las Rivas Sanz; Miguel Fernández-Maroto; Enrique Rodrigo González; Mónica Martínez Sierra	
Urban rehabilitation vs. urban regeneration. New perspectives and a critical perspective from the case of Castilla y León.....	182
Elizeu M. Franco; Mirian C. B. Oliveira; Natasha S. Pinto; Sérgio S. Lima	
Rialto farm in the 19th century brazilian coffee crisis.....	190
Carlo Berizzi; Rosamaria Olivadese	
Regulatory guidelines for the reuse of the existing buildings.....	198
Maura Percoco; Maria Argenti	
Urban regeneration + social integration. Rome as a case study.....	206
Rafael García Quesada	
Energy systems to efficient cities. The use of renewables and cogeneration	214
Erika Ficarelli	
Civil government of Tarragona: expression of a new modernity and its relationship with ancient city.....	221
Anna Anzani; Angela Baila	
Enhancing the ch: psychological and aesthetic issues.....	228
Angela Silvia Pavesi	
Social housing for the regeneration of built environment.....	235

**TEMA 2. TECHNOLOGIES AND OPERATIONAL METHODOLOGIES FOR PRESER-
VATION**

Giovanni Minutoli	
Pontedera school, static analysis of the building.....	244
Juan Carlos Navarro Fajardo; Luís Palmero Iglesias; Esther Capilla Tamborero; Rafael Raga Lluésma; Vicenta Calvo Roselló; Jorge Francisco Martínez Piqueras; Serena Moita	
Architectural heritage reviewing and catalogation. The church of Santiago in Villena's vaults.....	252
Michael J. K. Walsh; Werner Schmid	
Emergency conservation of medieval murals in northern Cyprus: St. Anne's church, Famagusta.....	260
Juan Carlos Pérez-Sánchez; Beatriz Piedecausa-García	
Restoration of religious temples: intervention in the church "Nuestra Señora de Belén" in Crevillente (Alicante).....	268
Ippollita Mecca; Laura Borriello	
Forgotten architectures: palazzo Calenda in Picerno (Italy).....	276
María Elena Zapatero Rodríguez	
Tangible and intangible building values.....	284
Luis Fernando Guerrero; Francisco Javier Soria	
The use of sustainable plasters for the conservation of earthen archaeological architecture.....	291
Graziella Bernardo; Antonella Guida	
Heritages of stone: materials degradation and restoration works.....	299
Benedetta Marradi; Myriam Di Cosmo; Silvio Levrero; Giuseppe Schiavone	
The town hall of Marcianise (ce): interventions for the reuse and enhancement of the building.....	307
Enrique Castaño Perea; Alberto Garín; Julián De la Fuente Prieto;	
The graphic documentary sources in the restoration. Past and future.....	315
Nuria Rosa Roca; Juan Roldán Ruiz; Mercedes Galiana Agulló; Ana Lasheras Estrella	
Use of new technologies to improve catalogs of built heritage.....	323
Angelo Lucchini; Enrico Sergio Mazzucchelli; Sara Mangialardo; Margherita Persello	
A new clt system for masonry construction refurbishment.....	331
Giovanni Semprini; Giulia Ruscelli; Livia Vannini; Dario Vannini; Claudio Galli	
Energy saving in the restoration project.....	339
Juan Carlos Miranda Santos; Bruno Persichetti; Cosimo Venneri	
The feudal castle of Ginosa (ta): the process of knowledge for the consolidation and the reuse.....	347
Pierluigi De Berardinis; Stefania De Gregorio; Emanuele Centi Pizzutilli	
Energetic and sustainable post-earthquake rehabilitation of the historical heritage for the realization of a mixed use building in l'Aquila.....	355
Jose Luis Cabanes Ginés; Carlos Bonafé Cervera	
North tower of Buñol castle. modeling with free software.....	363
Toshiei Tsukidate	
Restoration of washed house by the greates east japan earthquake.....	371

Riccardo Tesse; Elena Juárez Alonso	
Project of consolidation of the signa State Stadium	379
Paula Valéria Coiado Chamma; Juliana Cavalini Martins; Rosio Fernández Baca Salcedo	
Technology and building rehabilitation in the historic center of Sao Paulo ..	387
Federica Loccarini; Giovanna Rancocchiai; Mario Fagone; José Ramon Ruiz Checa	
Peeling tests on reinforced earth specimens.....	395
Paola Gallo	
Historical character and adaptability to energy efficiency performance in the recovery. Two case studies in Florence.....	403
Valentina Cristini; José Ramón Ruiz-Checa	
Regional analysis about guild unions and institutions linked to constructive traditional materials.....	411
M. Teresa Campisi; Valeria Fazzino	
Energetic riqualification of historic buildings: methodology of intervention among energy efficiency, conservation, sustainability. The case study of Militello palace in Enna (Sicily).....	419
Anna Manuela Gomes Rodríguez; Félix Lasheras Merino	
Characterization of the original natural lighting of Madrid baroque churches for its conservation and harmony with new artificial lighting.....	427
Quiteria Angulo Ibáñez; Borja Cerra Argente; Nerea Puente Rosello	
From black and white to color. The materialization of the facade of the casino	435
Riccardo Sinni; Eugenia Bordini; Lorenzo Rabizzi; Marco Repole; Elias Terzitta; Filippo Tiso	
School in pontedera: structural analysis, didactics.....	442
Pietro Matracchi	
Promoting patrimonial feeling of identity.....	450
Ilaria Conforte	
San Possidonio analysis of the church hit by earthquake.....	458
Fabio Minutoli	
Techniques for light and heavy efficiency of historic buildings.....	466
Angelamaria Quartulli; Piernicola Cosimo Intini; Piero Intini; Michele Vitti	
Masonry reinforcement among technique materia aspect.....	474
Adalgisa Donatelli	
Conservation and structural safety in seismic zone: first considerations about post-earthquake restorations made in l'Aquila (Italy).....	481
Luca Lanini; Chiara Porrone	
Remodelage of the postwar architectural heritage.....	491
Anna Livia Ciuffreda	
Seismic behavior of the church of San Possidonio (MO).....	499
Francesco Pisani	
Santa Verdiana: studies for the valorization and re-use.....	507
Jesús H. Alcañiz Martínez; Francisco J. Sánchez Medrano; Mercedes Galiana Agulló; Ana Lasheras Estrella	
Techniques of obtaining information for building restoration.....	515

Raffaella Lione	
Performance improvement: strategy to safeguard or illusion?.....	522
Carolina Aparicio Fernández; José Miguel Molines Cano; María Luisa Navarro García; Rafael Royo Pastor	
From tradicional architectura to low energy architecture.....	530
María Cristina Fregni; Enea Sermasi Micaela Goldoni; Fabio Camorani	
Innovative approaches for restoration: S.Agostino complex (IT)	538
Mariarosaria Villani	
The conservation of architectural surfaces. The facades restoration of San Biagio dei Librai and San Gennaro all’Olmo churches.....	545
Luis Palmero Iglesias; Pierluigi De Berardinis; María Cristina Forlani; Stefania De Gregorio	
Optimization of durability in the reuse of a steel element	553
Lorenzo Jurina; Gaetano Arricobene	
The consolidation of the crypt of sacromonte of varese	561
Antonio Martínez Molina; Claudia Mendoza Gómez; Sergio Cerra Rubio; José Luis Vivancos Bono; Isabel Tort Ausina	
Thermal comfort and energy efficiency in historic buildings with new uses..	569
Pier Paolo Lagani	
Capo d’orlando: analysis of the headland’s buildings.....	578
Antonio Pecci; Manuela Scavone; Nicola Masini; Maria Sileo; Antonio Dantonio; Cosimo Marzo	
Innovative technologies for cultural heritage: the unmanned aerial vehicles	586
Lorenzo Jurina; Alberta Chiari; Gianluca Gelmini;Valentina E. Morigato	
Steel stairs in ancient masonry towers.....	594
Lorenzo Jurina; Edoardo Oliviero Radaelli; Giovanni Michiara	
Seismic consolidation of duomo di colorno: modelling and interventions....	602
Isabel Martínez-Espejo Zaragoza; Gabriella Caroti; Andrea Piemonte	
UAV-based photogrammetry as an integration in multi-sensor architectural survey.....	611
Matteo Bigongiari	
Romena parish church, analys from the 3d survey to the consolidation project.....	619
Carmine Carlo Falasca	
A performance approach to the reuse of historic residential building.....	627
Marco Carpicci; Fabio Colonnese; Carlo Inglese	
The cave ‘unveiled’. The Karanlik monanstery and the digital representation of rupestrian heritage.....	635
GaiaTurchetti	
A valorization of the existing: the enviromental project.....	643
Francesca Albani	
Baroque stucco decorations and 20th century restorations. materials, tec- niques and conservation issues.....	651

REUSO 2015. VALENCIA

M ^a Teresa Broseta Palanca	
Sipacv: e-heritage project of valencian catalogues.....	659
Juan José Alcayna Orts; Pablo Vidal Fontiveros	
Enhancement with gis: la casa de la llum of Xàtiva	667
Jesús Anaya Díaz	
Digital design of resistant forms in architecture reuse.....	675
Sandro Paminello	
The survey of the complex of the Nativity church in Bethlehem.....	683
Jaime Llinares Millán; Manuel Ramírez Blanco; José María Bravo Plana-Sala; Ana Valls Ayuso	
Adapting the acoustic quality parameters in heritage spaces.....	691
Carlos Alberto Díaz Riveros	
Built heritage protection of adobe energy reduction bioclimatic architecture and in the eastern plains.....	699

TEMA 3. LIFE IN BUILDINGS AND HISTORICAL CITIES

Carla Benocci	
Rome and Parma under sforza authority:torrechiara dream.....	707
Juliana Cavalini Martins; Rosio Fernández Baca Salcedo	
Building rehabilitation for social housing in the historic center of São Paulo/ Brazil: an intervention in the existing heritage.....	714
Daniela Concas	
Buildings-churches as 'open' works of architecture: the preservation of the preexisting architectural space versus the functional requirements after the liturgical reform.....	723
Maria Grazia Ercolino	
Some reflections about cor-ten steel in the reuse of the historic buildings...	731
Federica Bergamini	
Knowledge and consciousness: keys for reappraisal of a historical town centre.....	739
Enza Tolla; Giuseppe Damone	
Survey and documentation of the historical center of the city of Potenza, prospects and future visions.....	747
Roberta Maria Dal Mas	
Pre-existence and project in the architecture of Giuseppe Momo.....	755
Francisco Hidalgo Delgado	
The ceramic pillars of central market of Valencia. Spain	763
Sara Núñez Izquierdo; Román Andrés Bondía	
Codifying the built heritage (ITC)	771
Malte Nettekoven; Edoardo Currà	
Construction in demolition. Investigating post-war architecture in west germany thanks to buildings pulling down.....	779
Ana Ferreira Ramos; José Mendes da Silvar	
The social sustainability in old city centres interventions.....	787
Anna Delcampo Carda; Ana Mª Torres Barchino; Ángela García Codoñer	
Diagnosis of the singular case of the historic center of Calp for knowledge and the preservation of its identity. An example of mediterranean historic center.....	795
Mª Remedios Zornoza Zornoza; Isabel Jordán Palomar	
Restoration of the six arcossolla south set and the ancient medieval cemetery enclose wall in san juan del hospital of Valencia.....	803
Antonio Paolo Russo; Alessandro Scarnato	
Reconstructing rio's tourismcape: urban reforms in the centro.....	811
Chiara Barbieri; Giovanni Zucchi	
Open project for a sustainable image of smaller centers.....	819
Gioele Faruggia; Gaspare Massimo Ventimiglia	
The urban restoration of the Rabato-Santa Croce district in Agrigento, Sicily: conservation, resilience and architectural morphogenesis.....	827

Luis Francisco Herrero García; Alfonso Fernández Morote A new typological interpretation as strategy to work in historical urban areas without monuments.....	835
Pascual A López Sánchez; Francisco José Sánchez Medrano Sustainability and historical neighborhoods: a case study: Moratalla (Murcia, Spain).....	843
Karolina Dudzic-Gyurkovich Authenticism and imitation in public places of a historical city.....	849
Rosa Elena Malavassi Aguilar Historic centre of San José? proposal for identification of patrimonial places in San José city, Costa Rica.....	857
Giuseppe Andrisani; Graziella Bernardo Heritage safeguarding for sustainable development of Tierrabomba island in Colombia.....	865
Serena Agresti; Pietro Petullà The regeneration of the area of Santa Rosa tower In Florence.....	873
Michela Cigola; Arturo Gallozzi Monuments of war. the abbey of Montecassino and its territory.....	881
Enrica Petrucci; Luca Vitali; Davide Severini Reuse of the St. Benedict monastery in Recanatì (Italy): a dialogue between old and new for sustainable development.....	889
Matylda Wdowiarz - Bilska Krakow historical center and the location of high-tech companies.....	897
Emanuela Chivoni; Fabiana Carbonari The "Chorizo House" in Argentina. Knowledge and documentation for architectural heritage's safeguard.....	905
Sibel Onat Hattap; Seyhan Yardimli Evaluation of religious architectural heritage belonging to minorities in Istanbul.....	913
Romelia Gama Avilez Dynamics of life in taxco traditional and tourist town.....	921
Carmen Vincenza Manfredi The transformation process of the Orvieto cathedral.....	929
Sheila Palomares Alarcón The urban fabric transformation of the Andújar market.....	937
María José Arroyo Hernández; José Barbero Muñoz; Francisco Javier Lafuente Bolívar; Manuel Montoya Sánchez; Jessica Rodríguez Martínez; Federico Salmerón Escobar; Juan Manuel Santiago Zaragoza Cosiendo heridas.....	945
Barbara Zin Modernist sacral architecture in the housing Estete space.....	953
María Rosaria Vitale; Eugenio Magnano di San Lio; Alfio Caltabiano; Maria Carmela Lombardo Reuse strategies for the historical centre of Paternò.....	961
Claudio Galli; Nicolò Minguzzi Reuse and linguistic researches for diacritical merges	969

REUSO 2015. VALENCIA

Hemilce Benavidez	
Valuation of residential architecture in seismic zone.....	977
Naima Abderrahim Mahindad	
The consequences of modern life in the casbah of Algiers.....	985
Elena Salvador García;Rubén March Oliver Rubén; Jorge Luis García Valdecabres	
Cataloguing as an instrument of knowledge, protection and enhancement.	
south set of San Juan del Hospital de Valencia medieval.....	993

TEMA 4. NEW CONSIDERATIONS FOR THE USE AND ENHANCEMENT OF MONUMENTS

Serena Motta; Paula Porta García; Irene Palomares Hernández; Raquel Torres Remón; Jorge Francisco Martínez Piqueras Analysis and historical survey of “Mulini Asciutti” in Monza park: proposals for intervention in the architectural heritage.....	1002
Enrique Martínez-Díaz; Francisco Hidalgo Delgado Tabacalera de Valencia, The end of the industry and its reuse to administrative building.....	1010
Pedro Verdejo Gimeno; Gracia López Paliño Intervention in a industrial heritage. The problem in the case of railway architecture.....	1018
Virginia Bernardini Monuments and wine and gastronomy: a compatible reuse.....	1026
David Navarro Moreno; María José Muñoz Mora The recovery of the suburban villas of Cartagena	1034
Maria Grazia Turco Architectural harmonies: a ‘sought-after’ compatibility.....	1042
Melinda Harlov A hungarian world heritage site and its adaptation process.....	1050
Stefania Landi Italian grain silos in the 1930s. Which reuse?	1057
Yesica Pino Espinosa Design as a search to a new interpretation. Industrial heritage into urban landscape.....	1075
Carmen Genovese Modern functions of monuments between conservation and contemporary instances. The case of the ex-convent of Gancia, building of the archivio di stato in Palerm.....	1073
Alfonso Cimino; Gaspare Massimo Ventimiglia Preservation of the remains and contemporary grafts in the former mother church of Santa Margherita di Belice in Sicily: ethics of restoration, conservation science and reuse.....	1081
Simone Lucenti; Marco Morandotti; Emanuele Zamperini The reuse of the Royal manufactories in Spain. The case study of the Real Fábrica de Paños of Brihuega.....	1088
Jaime Silva González Heritage railway in Guerrero, Mexico.....	1096
Monica Lusoli; Diego Lumare Riuso del “cimitero sotterraneo” in San Lorenzo a Firenze.....	1104
Mª Emilia Casar Furió Catalog as a regulator of uses and intervention.....	1112
Nilüfer Baturayoğlu Yöney; Burak Asiliskender From production to education – reusing Kayseri Sümerbank warehouse.....	1120
Antonella Guida; Antonello Pagliuca; Carmelo Cozzo Methodological approach of built heritage recovery. Best practice examples	1129

Sara Marini; Giulia Menziotti; Francesca Pignatelli; Chiara Rizzi	
Preservation and recycling. Between the real and the imaginary.....	1136
Burcu Selcen Coşkun	
Constructive conservation: a british approach to conservation.....	1144
Caterina Palestini	
Safeguarding and intervention: research on the reuse of the architectural heritage of the 20th century.....	1152
Silvia Crialesi	
Reuse of conventual complexes between history and contemporaneity.....	1160
Federica Gotta	
The enhancement project and its outcomes in the long term. The case of the archaeological site of Fileremo in Rhodes.....	1168
M ^a Lourdes Gutiérrez Carrillo; Isabel Bestué Cardiel; Juan Carlos Molina Gaitán	
Recovering the patio in mudéjar domestic architecture. restoration or reinterpretation?.....	1176
Nur Umar; M. Cengiz Can	
Reuse of the 19th century public heritage in Adana.....	1184
Bruno Matos; Francisco Barata	
"Reuse" of molinologic heritage.....	1182
Maria Agostiano	
Functional adaptation of underground sites: The case of the Sassi in Matera	1200
Giovanni Gatto; Tito Vaccaro; Gaspare Massimo Ventimiglia	
The restoration and reuse of sacred spaces in historical architecture: the church of the Santissimo Salvatore in Naro and the church of Santa Maria delle stelle in comiso, Sicily.....	1208
Alberta Lorenzo Aspres	
An approach to an analysis method for reused architectural heritage.....	1216
Adelaida Martín Martín; Lola Gámez Montalvo; Joaquín Passolas Colmenero	
Reuse of defensive structures in Al-andalus.....	1224
Nadia Ieksarova; Vladimir Yeksarov	
Reuse of railway lines for urban communicational spaces.....	1232
Alberto Grimoldi; Angelo Giuseppe Landi	
Opening the architectural heritage of the Comune of Cremona.....	1239
Maria Vitello	
Retrofit as compatible conservative action.....	1247
Antonio Giulio Loforese; Lucia Bergianti; Marcello, Cesini	
Tower - museum of waters in Colorno.....	1255
Romeo Cesare Renzo	
New life to a medieval tower.....	1263
Manuela Scavone; Nicola Masini; Emanuele Festa; Lucio Lisanti	
Restoration and reuse of architectural heritage.....	1270

Adriana Rossi	
The guiding principle of the project.....	1278
Giovanni Carbonara; Francesco Gagliardi; Nicola Giacobelli; Gianfelice Tinelli	
Archaeological museum setting-up into the castle of Leporano (Apulia, Italy).....	1286
Mateusz Gyurkovich	
Role of culture in revitalisation of the post industrial heritage in Poland.....	1294
Jacek Gyurkovich	
Restoring destroyed urban structures.....	1302
Vincenzina La Spina	
The reuse and musealization of architectural heritage.....	1310
Andrea Savorelli	
Let the merchants in the temple: the medioeval cloisters of S. Francesco grande in forlì from the 1837 transformation in food market to the 2014 project of restoration and enhancement.....	1318
Ciprian Buzilă	
Contemporary conversion of catholic sacred spaces in Rome.....	1326
Fauzia Farneti	
S. Maria della Grazia in ficarra, from a monastery to a town hall.....	1334
Lara Melo Souza; Marcos José Carrilho	
The “Sobrado Aguiar Vallim” in bananal (Brazil)	1342
Angelo Salemi; Attilio Antonio Mondello	
Knowledge as a prerequisite for the sustainable recovery of historic buildings: the churches of brotherhoods in the historic centre of Catania (Italy)	1350
Simona Talenti	
Preliminary procedures to the reuse of the seats of justice: parallelism France-Italy.....	1358
Anna Còccioli Mastroviti	
Piacenza, Teatini church: recovery and enhancement.....	1366
Laura Daglio	
Forgotten theatres. the reuse of Marengo theatre in Novi Ligure (AL)	1374
Irma de Ceglie; Teresa Demauro	
Porticus aemilla: the musealization of an urban archaeological area.....	1382
Antonella Versaci; Alessio Cardaci; Davide Indelicato; Roberta Andalaro; Luca Fauzia	
The park of the octagonal tower: a project of restoration and flexible reuse for the tower of Frederick in Enna (Sicily).....	1390
Elżbieta Waszczyszyn	
New uses of the historic hospitals - compatibility of interventions.....	1398
Salvador Mateo Arias Romero	
Granada cinema and its transformation to nightclub.....	1406
Miguel Ángel Ruano Hermansanz	
Rincón de Goya: his failed re-use for teaching purposal.....	1414
Laura Facchin	
Grosso palace and garden from country villa to town hall.....	1422

José Manuel Climent Simón; María Isabel Giner García; Enrique Gandía Álvarez The cullera Castle: restoration and re-use.....	1429
María Nieves Sánchez casado The Fontecha y Cano flour mill. Restoration and new uses.....	1437
María Jolanta Zychowski; Andrzej Bialkiewicz The old walls and modern art.....	1445
Mónica Fernández de la Fuente; Susana Mora Alonso-Muñoyerro Artillery towers in the island of Minorca. Compatible interventions in the architectural heritage and current uses.....	1453
Luis Cortés Meseguer; José Pardo Conejero; Salvador López Matoses Sueca public library: adecuation or rehabilitation?.....	1460
Donatella Rita Florino Defence heritage and military sites in the mediterranean area. Use, re-use, dis-use, ab-use.....	1468
Sara Inês Ruas Reuse of 20th century built heritage. The Batalha cinema in Porto.....	1476
Emma Barelles Vicente; Raquel Giménez Ibáñez Moya, restoration and putting in value.....	1484
Michele Benfari; Gaspare Massimo Ventimiglia The restoration of Santa Maria delle Grazie church in Santa Margherita di Belice (Sicily): conservation of the architectural remains and critical redefinition of the structural casing.....	1492
Silvia Bertacchi Documentation of "musealized" military heritage: the Verrucole fortress (Italy).....	1500
Sofía Martínez Hurtado; Santiago Tormo Esteve; José Manuel Dapena Alonso The third use of the remains of the communion chapel of the ancient Santa Tecla's church. Xàtiva	1508
Inés Martínez Gil ; Paula Porta García Pre-industrial set of Arcos' salt mines (salinas). Analysis and intervention of the Dolores' hermitage inside the salt mines.....	1516
Paula Porta García; Inés Martínez Gil; Raquel Torres Remón; Irene Palomares Hernández Present and future of industrial heritage: Frutagut's bulding in Oliva.....	1524
Silvia Arribas Alonso Implicit and explicit cultural uses of monuments.....	1522

TEMA 5. THE FRUITION OF THE HERITAGE: CULTURAL ROUTES AND LANDSCAPE

Francisco Javier Sanchis Sampedro; Adriana Rossi; Igor Fernández Plazaola; Francisco Javier Cárcel Carrasco	
Valencia: the urban transformation of a city by the Turia river reuse.....	1541
Francisca Roger Espinosa	
Roman aqueduct of peña cortada.....	1549
Beniamino Polimeni	
The cultural heritage of the Cheonggyecheon river: methodological and theoretical aspects of the su-pyo bridge restoration project.....	1557
Pedro Enrique Collado Espejo	
Tower and hill of el Molinete in Mazarrón. An example of reuse of monumental architecture and historical landscape.....	1565
Francisca Roger Espinosa	
Urban and historic landscape of la Serranía's villages.....	1563
Clara Villalba Montaner	
Revitalisation and refurbishment of the convent of the dominican nuns. Intervention in the context of the cultural landscape of Albarracín, Teruel.....	1581
Valeria Montanari	
The landscape of the Valnerina: peculiarities and protection.....	1589
Biotto Laura	
Harmony and simplicity in dry construction in Provence.....	1597
Vincenzo Pollini	
The promotion and representation of complex systems, through the food tourism.....	1605
Jorge Girbés Pérez	
Walking tours in the city of Valencia cemetery.....	1613
Antonio Taccone	
The enhancement of the Coastal urban heritage.....	1621
Vincenzo Bagnolo	
The mining village of Pranu Sartu: architectural survey of a housing unit.....	1629
Francisco E. Segado Vázquez; José Manuel Maciá Albendín	
The figure of architec-archaeologist and the valorization of the heritage.....	1637
Vanesa García Alcocer; José Juste Ballesta; Elsa María Soria Hernanz	
Urban regeneration in Daganzo (Madrid): restoration of the four sewers fountain.....	1645
Roberto Bolici; Giusi Leali; Silvia Mirandola	
Enhancement and re-use of the rural heritage.....	1653
Pablo Altaba Tena; Juan Antonio García-Esparza	
Pilgrimage roads of Sant Joan del Penyagolosa. Architecture and ethnography	1660
Lola Merino Sanjuán; Marina Puyuelo Cazorra; Mónica Val Fiel	
The Turia: a landscape of culture and civic experience.....	1668

Federica Gotta	
The scope of the ancient architecture, from the context to the archaeological site.....	1676
Marina Docci; Mario Docci	
Uses and reuses: requalification strategies between villages and castles in Valdelsa, near Siena (Italy)	1684
Sabrina Studart Fontenele Costa	
A “promenade architecturalle” in modern galleries of Sao Paulo downtown..	1692
Concepción López González	
Abstract cultural tours following the routes of control of the territory of the castles of Valencia.....	1700
Joaquín Ángel Martínez Moya; M ^a Jesús Máñez Pitarch; José Teodoro Garfella Rubio	
Valencian castle-palace route.....	1708
Oscar Abril Revuelta; Raúl Abril Revuelta; Félix Lasheras Merinor	
Analysis and proposals for the recovery of the interactions between architecture and landscap in a villa on the edge of the moor: the case of Urueña (Valladolid – Spain).....	1716
Yolanda Hernández Navarro; Pasquale de Dato	
The worker colony of Benagéber: the conservation of an industrial landscape.....	1724
María Luisa Ruiz-Bedia	
A cultural route based on hydraulic heritage. Ebro river (Spain).....	1732
Sergio Arturo Vargas Matías	
Still standing guardians project.....	1740
Pedro Rafael Blanco Gómez	
Mudejar ceiling in the church of San Antonio Abad in Valencia.....	1748
Sebastián Herrero Romero	
Complexity and readability at the mosque-cathedral of Cordoba.....	1756
Antonio Pugliano	
Researches and projects for the enhancement of the cultural landscape in rome metropolitan area.....	1764
Pasquale Tunzi	
Small group of houses of Preappennines Abruzzo: Picciano.....	1772
Cristina Coscia	
The enhancement strategies of the “Caseforti” system (Piedmont region, Italy): a gis-prototype to support the redevelopment scenarios.....	1780
Silvia Augusta Cirvini	
The wine landscape Mendoza, Argentina.....	1788
Carmen Cárcel García; Pedro Verdejo Gimeno	
A walk through the old village of Campanar. Valencia.....	1796
Francesca Geremia	
Documenting the vanished Alessandrino district of Rome.....	1804
Elena Mussinelli; Andrea Tartaglia; Raffaella Riva; Chiara Agosti	
Design and strategies for rural heritage enhancement.....	1812

Lucia Giorgetti; Gaia Petroni	
The public channel: a water route.....	1820
Matías Gisbert Vivó; Simeón Couto López	
Blai's water mill in Massamagrell (Valencia): enhancement of industrial architectural valencian heritage.....	1828
Jolanta Sroczynska	
Social access to cultural heritage - The role of local communities in protection of historic districts.....	1836
Antonio Cappuccitti; Alexandra Afrasinei	
The fragility of the historical city opposite natural disasters.....	1844
Alessandra Pagliano	
Anamorphic perspectives for archeological heritage.....	1852
Rosa María Pastor Villa	
Itinerary in el cabanyal.....	1860
Olimpia Niglio; Yumiko Oda; Shoel Ohno	
Gold and silver. Archaeological landscape of Sado Island in Japan.....	1866
Laura Pennacchia	
Virtual routes in the lost jewish ghetto of Rome.....	1876
Rodrigo De la O Cabrera; David Escudero Boyero; Nicolás Marín Carretero	
Cultural landscapes of energy in the photographic historical funds.....	1884
Barbara Tetti	
Metropolitan city and extramural. the manufacturing and environmental complex of the river Guadaira in Seville.....	1892
Irene de la Torre Fornés; María Encarnación; Carmona Belda	
Landscape and context as parts of the heritage of Tuéjar.....	1900
Linda Puccini; Andrea Marmorì	
The fruition of the patrimony of Alloria. restoration proposal.....	1908
Andrea Pirinu	
Historic villas in the countryside of Bosa in Sardinia. surveys for the restoration and enhancement of abandoned heritage.....	1916
Antonio Jiménez Delgado; Carlo Manfredi; Paola Travaglio; Pablo Vengoechea	
The town of huéscar: conservation of cave-houses as a tool of urban development.....	1924
Luis José García-Pulido; Virginie Brazille Naufet	
Improving the cultural heritage and the landscape of the hill of the castle from Montejicar (Granada).....	1931
Luis José García-Pulido; Virginie Brazille Naufet	
Consolidation of the tower of Agicampe (Loja, Granada)	1939
Luis José García-Pulido; Rafael de la Cruz Márquez; Virginie Brazille Naufet; Luca, Mattei	
Restoration of the environmental and landscape benefits of the historical water channels of the Alhambra.....	1947

Irene Palomares Hernández; Paula Porta García; Raquel Torres Remón La construcción tradicional del barrio del Cabañal de Valencia.....	1955
Emanuele Romeo Ruins and classical fragments in the city of Lugdunum: conservation and enhancement of the historical memory.....	1963
Emilio Faroldi; Maria Pilar Vettori History and landscape. a project for Pinocchio.....	1971
Leila Signorelli Nature and landscape between preservation, transformation and reuse in the ex psychiatric hospital in Rovigo.....	1979
Luciano Serchia; Anna Caccioli Mastroviti Recovery and enhancement of Torrechiara castle.....	1987
Angela Bonafiglia; Raffaele Catuogno Morphometric survey of medieval settlements.....	1995
Cristina Jorge Camacho The water, welfare and educational laboratory of the la granja de San Ildefonso gardens.....	2003
Paola Raffa Global resource for save the heritage: Draa Valley in Morocco.....	2011
Rafaél Temes Cordovez Itinerary interpretative in the Patrix neighborhood. Recovery of agricultural, industrial and worker past.....	2019
Nazila Khaghani Conservation, restoration, redesign purposes for the touristic zone of industrial area of Bushehr (Persian Gulf).....	2027
Daniel López Bragado; Eduardo Antonio Carazo Lefort The model in the teaching of historic city. Stages of urban transformation of Zamora through a three-dimensional virtual itinerary.....	2035
Roberto Sabelli A project for conservation and valorization of the archaeological park of Populonia.....	2043
Maria Piera Sette Forms of landscape, environmental system and historicity of the settlement processes; prospects for the protection and enhancement.....	2051
Maria José Gomes Feitosa Macau and Salvador: an analysis of world heritage.....	2059
Behice Bilgi Solduk; Nur Umar Strategies for the conservation and reuse of cultural landscapes: the case of ancient Hevsel gardens in Diyarbakir.....	2066
Roberto De Lotto; Cecilia Morelli di Popolo; Elisabetta Maria Venco Cultural heritage in urban development.....	2074
María Dolores Robador González The light of cities.....	2082
Claudio Mazzanti The de Filippis-Delfico Palace in Montesilvano Colli (Italy).....	2090

REUSO 2015. VALENCIA

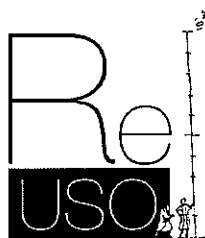
Nausikaa Rahmati Mandana; Noemi Casula	
Faro Capo Spartivento: an icon of modern history, nature and tradition.....	2098
Eduardo Robles	
Plantations and canopy roads: traditional landscapes of north Florida.....	2106
Carmela Canzonieri	
Reading through the lines, new awareness of the linear danewerk fortification in its landscape.....	2114
Luca Cipriani; Filippo Fantini	
Cultural heritage through 3d models: the Porticoes of Bologna.....	2122
Stefano Bertocci	
Documentation of Adrian's Villa at Tivoli: digital survey for conservation and evaluation of archaeological areas.....	2130
Emanuele Giaccari; Antonio Riviello	
The fusion between the geological and urban landscapes in Lucania (Italy)...	2138
Antonio Conte	
Carved architecture into the mediterranean experience of Matera's sassi.....	2147

TEMA 6. THE INTERVENTION ON THE HISTORICAL HERITAGE AND EDUCATIONAL EXPERIENCE

José Antonio Mendes da Silva	
Full and pedagogical access to a restoration site – the Tower of the University of Coimbra.....	2156
Riccardo Rudiero	
The active conservation of the landscape through the widespread museums	2164
Betânia Brendle	
Cesare Brandi’s theory as a methodological framework for architectural intervention in the built heritage: a didactic experience in Brazil.....	2172
Walter Peters; Aletta Olivier	
Urban morphology & academic writing: a pedagogic experiment.....	2180
Maria Bruna Pisciotta; Valentina Spataro	
Surface grooves and subtracted architecture. voids in the mediterranean landscape.....	2188
Laura Balboni; Carolina Di Biase;Stefania Terenzoni	
The “Casa del Balilla” in Mantua (1932-1933): the limits of restrictive protection and possible new uses.....	2196
Concetta Fallanca	
Educational urbanism for the historical heritage.....	2205
Natalina Carrà	
Education heritage and shares urban planning.....	2213
Silvio Van Riel	
The methodological bases for a culture of build-ing reuse.....	2221
Giovanni Battista Cocco; Caterina Giannattasio; Sara Fois; Martina Porcu	
Utopia is reality. The architectural design between anclent and new.....	2228
Claudio Galli; Concetta Chiara Iacovella	
Analysis methods for the preservation of Bologna municipal palace	2236
Francisco Javier Lafuente Bolívar; Ana María Cruz Valdivieso	
Promoting patrimonial feeling of identity.....	2244
Luis Francisco Herrero García; Alfonso Fernández Morote; Paula Cardells Mosteiro; Lucía Martínez Estefanía	
Drawing cities: drawing as a tool to learn and tell the city.....	2252
Fabiola Colmenero Fonseca	
The heritage garden Ambassadors science-based, with the new design proposal through the educational experience in the city of Guanajuato, gto. Mexico.....	2260
Michela Benente	
The accessibility of the gardens of Villa Della Regina in Turin as an opportunity for valorization.....	2267
Déom Claudine	
Finding a good fit.....	2275

Susana Mora Alonso- Muñozerro; Pablo Fernández. Cueto; Sara Peñalver Martín	
More than aesthetics.....	2283
Juan Manuel García Martínez	
Free entry to heritage in the classroom.....	2291
Paula Valéria Coiado Chammar; Rosio Fernández Baca Salcedor	
Teaching of architecture, heritage and culture.....	2299
Pedro Verdejo Gimeno; Carmen Cárcel García	
Designs on the reuse of minor heritage.....	2307
Alba Soler Estrela; Rafael Soler Verdú; Manuel Cabeza González	
A disappeared vault in the gothic-renaissance palace of Oliva, Spain. analysis of traces and typology.....	2315
Ewa Węclawowicz-Gyurkovich	
New interventions in historical castles in Poland.....	2323
Roberto Silguero Ayuso; Román Andrés Bondía	
Is the castle square the town square?.....	2331
Maria Grazia Cianci; Sara Colaceci	
The via latina: analysis, reading and interpretation of the ancient landscape. Methodology and enhancement of heritage.....	2339
Flora de los Ángeles Morcate Labrada; Juan José Martínez Portilla; Juan José Martínez Bóquera	
Agreement between universities: the interinstitutional collaboration and his incident in the knowledge of the heritage constructed for his preservation and conservation.....	2347
Laura Gioeni	
Marco Dezzi Bardeschi: ex fabrica ad doctrinam.....	2354
Michele Zampilli	
Teaching the smaller urban centers restoration.....	2362
Rita Binaghi; Maria Pia Dal Bianco	
Piazza San Carlo in Turin: considerations.....	2370
Carmen Moral Ruiz	
Learning by transdisciplinarity.....	2376
Giuliana Carolani; Lorenzo Cantini	
The rehabilitation of Villa Bagatti Valsecchi in Varedo (MB) as an example of policy for urban recovery.....	2384
Alfonso Ippolito; Cristiana Bartolomei	
Survey and gathering: low cost documentation.....	2392
Isabel Bestué Cardiel; M ^a Lourdes Gutiérrez Carrillo; Juan Carlos Molina Gaitán	
The transmission of technical building concepts applied to architectural-heritage. A teaching experience in technical schools.....	2400

TEMA 2 – TECNOLOGÍAS AL SERVICIO DE LA RESTAURACIÓN
TECHNOLOGIES FOR THE RESTORATION



**III Congreso Internacional sobre Documentación,
Conservación, y Reutilización del Patrimonio
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HISTORICAL CHARACTER AND ADAPTABILITY TO ENERGY EFFICIENCY PERFORMANCE IN THE RECOVERY. TWO CASE STUDIES IN FLORENCE

CARATTERE STORICO E ADATTABILITA' PRESTAZIONALE PER UN RECUPERO ENERGETICAMENTE EFFICIENTE. DUE CASI STUDIO A FIRENZE

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ABSTRACT

A renewal energy project on the historical buildings, with introducing innovative technologies and components that ensure optimal performance, open a difficult question on the evaluation if, technologies for energy savings and/or use of renewable energy, are a "threat" for the building, even if these innovative interventions contribute effectively to the preservation of existing historical buildings and then to the preservation their cultural value.

To overcome this different cultural vision, the challenge is to pursue a more coordinated and cross-sectoral planning, together with a decision-making process based on a holistic view of the built environment.

The paper present two case studies that have pursued this objectives; two projects of buildings recovery, both funded by the European Commission in the Framework Programmes, with relevant interventions of renewal, respecting their historical characteristics, with the aim of improving the performance characteristics for their conservation.

Keywords

Energy, efficiency, energy, recovery, energy saving.

1. INTRODUCTION

The built environment has a central role in our society: buildings are not just the place where we live and work but the building sector is also an important segment in our economy. Yet, the energy performance of existing buildings is poor so that they are responsible for a large share of the overall energy consumption (40% within the EU) and they are also one of the most significant sources of greenhouse gas emissions (36% within the EU).

Thus, buildings are also relevant for the achievement of the energy and climate objectives of the European Union (EU) for the future (2050).

Considering that the average life span of a building is over 50 years and that a complete renewal of the existing building stock would take about 100 years, investing in building refurbishment is crucial to reduce energy consumption and greenhouse gas emissions in the EU. In fact, it is important to achieve the EU energy and climate objectives, it is necessary to refurbish all¹ (or almost all) buildings by 2050.

In detail, historic buildings today play an important role for the community compared to what happened in the past. Such buildings, in fact, beyond their beauty and recognition of their value, are essential as the bearers of our historical identity. Cultural heritage is a significant force for 21st century Europe; not only is it at the heart of what it means to be European, it is being discovered by both governments and citizens as a means of improving economic performance, people's lives and living environments.

The need to recovery, in terms of energy, the historic building heritage and therefore the possibility of introducing innovative technologies and components that can ensure optimal performance, however, pose the difficult question on the evaluation if intervention technology to reduce energy consumption and/or the supply of renewable energy, is to be considered a "threat", while acknowledging that effectively contributes to the use and the long-term preservation of an existing historic building and then to the preservation of its cultural value.

Additional questions, such as preservation and aesthetic aspects, arises. In fact, individual solutions have to be found with advantages and disadvantages which cannot be weighted clear without ambiguity, since it is a widely interdisciplinary field.

There are many techniques available today, which are originally developed for new buildings in order to enhance comfort and energy efficiency for several building typology (dwellings and non-residential buildings).

So, a lot of lessons learnt from low energy and passive houses in terms of new buildings can be transferred to the wide field of refurbishing and retrofit. In fact, the basic principles of building physics are valid for both, but individual solutions have to be found, to adapt all the technical procedures as well as the available products, to the energy recovery of historical buildings.

The paper present the available solutions for energy retrofit of two historic buildings in Florence; the objective is to find out the open questions stimulating the discussion thought this case studies and illustrate expertise of different approaches.

2. CONTENTS

Before starting to refurbish an existing building it is fundamental to carry out an analysis of the actual existing building's performance and condition to understand which areas need to be improved to achieve current benchmarks in terms of energy saving, comfort, security and life safety. A baseline can be established by conducting an accurate audit, carried out as a systematic examination and measurement of key aspects of all the building. The main aspects to be considered are energy consumption, occupant satisfaction, facilities management operations, indoor environmental quality, water consumption, waste generation and not least, the necessity to preserve historical parts of the building (Pfluger R., Baldracchi, P. 2011). In detail, it is important to understand the past of the building with regard to its function and to all the changes brought out during its life from structural, envelope, electrical and mechanical systems point of view. After the audit it is possible to establish targets and goals and the appropriate level of refurbishment based on the building condition and level of refurbishment required.

This paper presents results of the architectural and energy retrofitting of two case studies in Florence, carried out applying appropriate and strategic low-energy and sustainable techniques and of the monitoring campaign (IAQ, thermal comfort, light, acoustic) performed first to evaluate the existing situation and then to verify comfort parameters and the energy consumption after works. Either case studies, the Bardini Museum, that the new offices for A. Mayer Paediatric Hospital, was, financed by EU Commission in the FPV Programme. The results of this projects are to provide with a direct guidance, complete with architectural and engineering examples, for design professionals and authorities, setting a new standard for energy consumption in museum and offices buildings. In parallel, it has aimed to disseminate effective information for designers and local authorities and to demonstrate the efficiency of the measures in order to promote them in efficient market promotion, penetration and utilization.

2.1 The Bardini Museum project

The case study of Bardini Museum in Florence participated to MUSEUMS project (NNE5/1999/20). The first intention was to demonstrate that an energy efficient and sustainable museum building design can fully meet the architectural, functional, comfort, control and safety requirements, but the main objective was to apply and test new and innovative technologies in museums in order to achieve total energy savings of over 35% (for retrofit) and reduce CO₂ emissions over 50%, directly contributing to the preservation of European cultural heritage and to the acceptance of innovative and renewable technologies in public buildings.

The Municipality of Florence, Italian Partner of the project, selected the Bardini Museum as case study and paradigm of the Italian Museum Building (Gallo, P., 2007). This historical museum is also one of the most important buildings of the Italian Renaissance, and the intervention of retrofitting has taken account these architectonic and artistic values. This building represents one of the most important buildings of the Eclectic period, and it was

projected and realized in 1883 by the Italian architect Bardini restructuring an old church with monastery in order to contain and show his art collection.



Figure 1 The Bardini Museum

The building, north–south oriented, it was naturally ventilated and had no air conditioning system installed. The building has a very heavy structure: in fact, the traditional stone construction is characterized by a massive wall but the older shell had many problems of structural and functional obsolescence as follows:

- obsolete environmental conditions for visitors and staff related to air quality, thermal and visual quality;
- excessive energy consumption; i.e. lighting represented 70% of the total energy consumption due to insufficient and obsolete devices in the exhibition spaces, absence of detectors, absence of day lighting compensation system;
- inefficient use of energy due to bad building maintenance and obsolete equipment;
- damaged windows and windows frames;
- high air infiltration rates;
- inadequate spatial organization of exhibition space.

2.1.1 Elements of the environmental design and innovations in design strategies: building energy performances

The task project was primarily to modulate spaces and services to users' and workers' demand in order to correspond to technological and serviceable requirements, also according to legislative regulations.

Three main scopes have been individualized:

1. Improvement of the building envelope (insulation, glazing, natural ventilation and daylighting techniques) to reduce the thermal losses of the building.
2. Improvement of energy systems used for heating, cooling, ventilation and artificial lighting to decrease the specific energy requirements in each sector.

3. Improvement of control strategies (BEMS, distribution/demand control strategies, intelligent control, etc.) to optimize the performance of the various systems and properly adjust their operation.

Daylight and artificial lighting

The improvement of the old luminaries without efficient reflector was been a very important measure because the surface inside the luminaries should have been more reflective so that more light should have been directed onto the exhibition space (Pohl W., 2009). The use of efficient luminaries with a special reflector can reduce glare and increase illumination levels. This retrofitting measure has provided the required lighting levels with half the number of fixtures, has reduced glare, and increased the illumination levels.

The day lighting level has been optimized by the replacement of existing skylight with new ones. The first step was to change the skylight roofing structure in the main room near the entrance. In place of the heavy glazed roofing, were used luminaries that are transparent 30mm twin-welled polycarbonate panel with a special reflector which can reduce glare and increases illumination levels. A second measure regards the existing wooden false ceiling: all the bulletproof glasses were replaced with special high-transmittance diffuser components made of a high-grade flexible plastic in a position to assure a uniform luminance distribution at the ceiling in the room, apart from a good acoustic.

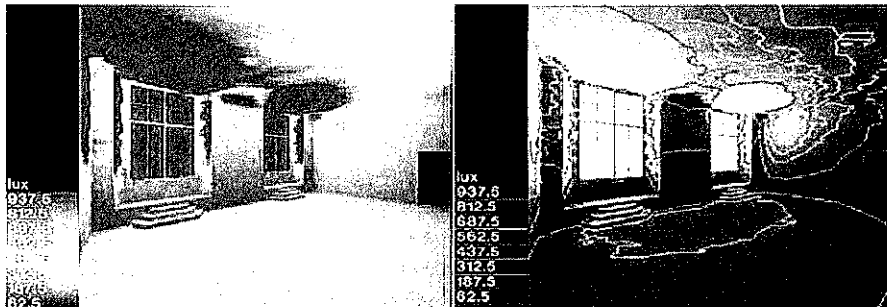


Figure 2 Example of Radiance simulations of "Sala del Terrazzo"

Building performance

In order to complete the energy and environmental design phase, several simulations were performed using validated simulation tools (Esp-r and Radiance) to optimize the design of each specific measure applied in the museum, especially the daylighting improvement measure (Bartolo, R., 2003).

To evaluate the internal comfort of visitors and exhibited materials, particularly to calculate the distribution of the indoor temperatures, as well as the energy required for heating and cooling purposes, Esp_r software has been used. A second simulation was performed to optimize the daylighting design phase. For the evaluation of visual performance, the Radiance tool has been used for the calculation of daylight in interior spaces, the analysis of glare problems, luminance and so on.

These simulations have shown a significant reduction in transmittance using high diffuser in place of the existing glass.

2.2 The project of Meyer's paediatric hospital offices

The project's global objective of "Retrofitting for Environmental Viability Improvement of Valued Architectural Landmarks" (REVIVAL) (Gallo, P., Di Stefano G., 2006), was to demonstrate that non-domestic buildings from the post-war pre-energy conscious era, can be refurbished economically, with improvements in energy performance that lead to lower life-cycle CO₂ emissions than the original buildings. The Italian case study, was related to the upgrading of *Villa Ognissanti* that represents the historical hospital complex, into a beautiful park on hills of Florence. The Villa was not suitable to be used as a hospital and was retrofitted and used as reception and contains office for administrative and managerial functions.



Figure 3 The Villa Ognissanti before refurbishment

The overall objective of the Meyer project was to demonstrate that a holistic approach to the refurbishment of existing offices can lead to an energy efficient working environment with optimised energy, sustainability and technological systems and techniques. This approach have ensured maximum possible energy conservation, as well as the best possible indoor environmental quality together with the adoption of more sustainable operational modes.

Fabric refurbishment works included the replacement of the original roof structure and substitution of window frames to reduce air infiltration. In terms of servicing, an HVAC plant equipped with heat recovery was introduced. The project, as innovative design strategy, has integrated a greenhouse with a PV plant incorporated (for the total amount 30 kWp), in front of the central pavilion that works as a buffer zone in winter, to minimize heat losses, and also to increase natural ventilation through a stack effect; thus reducing cooling demand and associated energy costs. In fact, the main objective of this project was to design the refurbishment of the offices Meyer Hospital building, according to the principles of energy efficiency, minimum environmental impact and best integration of energetic technologies into the architectural context.

2.2.1 The greenhouse: high energetic efficiency measure

The greenhouse plays an important role among energetic strategies adopted in this project: in fact it is a buffer space as it gains heat from the adjacent rooms as well as from solar radiation. On sunny days in spring and autumn the greenhouse temperature rises above that of adjacent offices. In this condition, overall when such times coincide with occupancy and

heating schedules, the greenhouse makes a net contribution to space heating: up to 17 % of the total heating loads. Occupants not only have the benefit of lower energy bills but also it can be a most comfortable area of the building on sunny winter days. This is due to the large area of contact between greenhouse and parent buildings and to the thermo-physic characteristics of transparent elements of the greenhouse.

The project is a pilot action for the development of the semi-transparent PV technology and represents the first significant example in Italy (Gallo P., 2009): useful and successful collaboration between architects, engineers, PV producers and company experts has allowed the experimentation of innovative PV technologies integration, improving their market penetration in Italy. Thus, this demonstration project is definitely necessary as it will be used to set up future standards for sustainable building designs. By doing this assessment and establishing of best practices, the project may lead also to a first step in the development of norms and regulations for use in National and European scale.

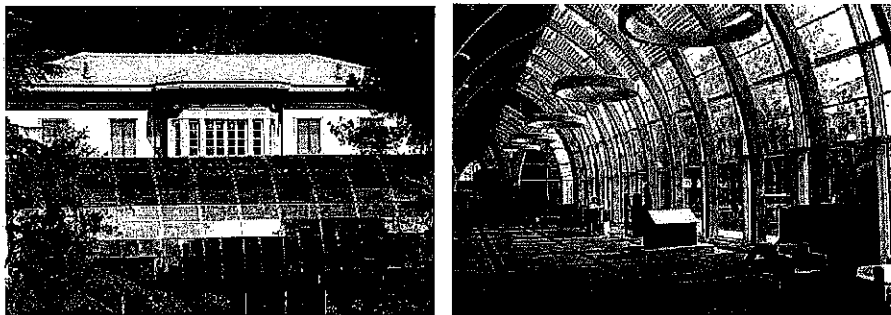


Figure 4 The PV greenhouse

Building performance

Simulations have been conducted to assess the potential for natural cross and night ventilation through the greenhouse. Advanced control strategies have been adopted in order to measure, monitor and record the internal conditions. Moreover, during construction, sustainable practices such as reduction of the use of primary raw materials and recycling of construction related waste were applied, together with an evaluation of the environmental implications relating to the use of ecological materials (availability on the market, procedures of setting up, etc.). A procedure for life-cycle analysis were developed early in the project to assist the prioritising of various environmental measures. This greenhouse, has had a value not only for the significant energy reduction of the adjacent buildings or for the PV system integration in an existing architecture but also for its social effect: the improvement of the working and conditions for staff and consequently quality of life have a big payoff whenever an office is turned into a eco-building office. The pay back of any expenses is often much quicker than projected because of a great increase in employee productivity. Finally, the application of new products and new technologies (Gallo P., 2013) developed into the framework of this project have assessed efforts of the European industry into commercialize these products, and have permitted a better penetration, of solar and energy efficiency products, into the building sector in Italy.

3. CONCLUSION

This two demonstration projects have had aims to contribute to significant decrease in energy consumption and peak electricity demand for lighting, as well as to obtain a considerable improvement of comfort and indoor conditions through the application of high energy innovative measures. In parallel, they were aims to disseminate effective information for designers and local authorities and to demonstrate the efficiency of the measures in order to promote them in efficient market promotion, penetration and utilization.

The qualitative impacts obtained are as follows:

Environmental impacts. Important indirect environmental benefits were obtained with the reduction of CO₂, CFC and the reduction of pollution caused by the use of electricity and thermal energy; furthermore, the application of retrofitting measures have improved of indoor air quality, and allowed the correct level of thermal comfort avoiding the health hazards resulting from inadequate indoor conditions.

Health impact. Application of retrofitting actions have contributed to improve indoor air quality, avoiding health hazards.

Social impacts. Application of retrofitting actions has had a significant impact by creating healthy and comfortable indoor environment and increasing the diffusion of sustainable consciousness in users and owners.

NOTES

1. Following the definition of the Energy Performance of Buildings Directive (EPBD), certain buildings are exempted from the regulation of renovation: first, officially protected historical buildings or buildings of architectural merit; second, places of religious activity and worship; third, industrial buildings used for less than two years; fourth, buildings used in less than four months of the year or consuming 25% of the energy they would need for whole-year operation; fifth, stand-alone buildings having a floor area less than 50 m² (EU, 2010a).

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